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Zero Retries is an independent newsletter about technological innovation in Amateur Radio.

About Zero Retries

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In this issue:

- **Request To Send**
- **A Vision for Zero Retries Interesting Amateur Radio in 2029**
    - **AmGEO-200 - Western Hemisphere GEO Payload**
    - **Amateur Radio Networking**
    - **Amateur Radio Standards Organization (ARSO)**
    - **ARSO Conferences**
    - **Amateur Radio Internet**
    - **Amateur Radio Regulatory Updates**
    - **Amateur Radio Omnipedia**
    - **Funding for Amateur Radio**
    - **Emergency Communications**
    - **In Conclusion**
- **Feedback Loop**
- **Join the *Fun* on Amateur Radio**
- **Closing The Channel**

Request To Send

As Zero Retries closes out 2022, the subscriber count is more than 665 co-conspirators for Zero Retries Interesting activities such as digital, satellite, microwave - *the fun stuff*! It's fun having all of you along for the ride.

While I do see the email addresses as you subscribe to Zero Retries, only some subscribers use a callsign in their email address. Thus I often have no idea who you Zero Retries subscribers are (thus it's a pleasant surprise when folks mention that they're a subscriber). Please feel free to introduce yourself and let me know what you like (or don't like) about Zero Retries. Some updates I plan to make in 2023 will make this easier.

One bit of administrivia - previously, I would keep comments open for the five most recent issues. Given that some issues receive no comments at all (such as Zero Retries 0075, 0076, and 0077), if an issue doesn't receive any comments within one week, I will close comments as soon as the subsequent issue is published.

Happy 2023 all!

de Steve N8GNJ

A Vision for Zero Retries Interesting Amateur Radio In 2029

In lieu of drinking from the firehose of Zero Retries Interesting news inputs for this final issue of 2022, I thought I'd indulge in some optimistic fiction of an imagined Zero Retries Interesting future of Amateur Radio. All of what I'll describe here is, in my opinion, conceivable, extrapolating from technology and trends of 2022 forward through the end of this decade.

To reduce confusion, any invented[1] organization, projects, or products I mention in this story are italicized at first use. As usual in Zero Retries with just me as an author, this imagined future is mostly a US-centric worldview. Apologies for that - while there is a lot of Zero Retries Interesting activity occurring outside the US, I don't have enough exposure to Amateur Radio in other countries to incorporate more than a smattering of non-US projects that I'm able to follow.

All real organizations, projects, or products mentioned here (example - QO-100) are easily discoverable with a quick web search.

*The following is a **fictional story** - not real life.*
Don't take anything said here seriously. Please!

AmGEO-200 - Western Hemisphere GEO Payload

In the late 2020s, thousands of Amateur Radio Operators use *AmGEO-200*, the satellite payload in geosynchronous earth orbit (GEO) above the Western hemisphere. Because AmGEO-200 was designed as digital-agnostic, there are hemisphere-wide voice nets, text chatting, email, repeater linking, regional network linking, bulletins, flood file distribution, video (various resolutions), grid square contesting… anything that can be converted into a bitstream.

AmGEO-200 is so popular that a traffic management system had to be developed. When users want to use non-realtime (such as email) traffic, the user station requests time to send its email, and the traffic scheduler slots in the request when there's a break in realtime traffic. The traffic manager function really came into its own when the gateways in Brazil came online to route traffic between QO-100 and AmGEO-200. The Brazil gateways enabled users of QO-100 in the Eastern hemisphere and users of AmGEO-200 in the Western hemisphere to route between the two because the Eastern tip of Brazil was within the footprint of both QO-100 and AmGEO-200.

The first user earth stations for AmGEO-200 were a bit expensive and fussy to get working, but eventually prices came down and users got the hang of aiming their dishes precisely to transmit on 5 GHz, and reliably receive the 10 GHz downlink. AmGEO-200 transmits a number of beacons with varying speeds and forward error correction to help new users aim their ground stations. AmGEO-200 is particularly popular with Amateur Radio Operators that live in condominiums and apartments because AmGEO-200 ground stations are indistinguishable (to most people) from Direct Broadcast Satellite (DBS) dishes, which are usually allowed on balconies.

One of the more popular events on AmGEO-200 is "experiment night" that runs for 12 hours beginning at 18:00 Central on the first Saturday of the month. Software authors use experiment night to test new builds of software, and experimental modes can be used without prior coordination with the system managers. Hardware hackers use experiment night to see how minimal (or maximal) a ground station can be used on AmGEO-200.

AmGEO-200 was built, sponsored, and managed by *Amateur Radio GEO Association (AmGEO)*, a not-for-profit organization that was initially formed to raise funds to build, integrate, and launch AmGEO-200. In part, AmGEO was formed to tap into the energy, enthusiasm, and capabilities of younger folks interested in Amateur Radio and space. AmGEO proved to be surprisingly successful in engaging younger folks and growing the number of Amateur Radio Operators. AmGEO is a virtual organization, hemisphere-wide and generates enthusiasm for Amateur Radio by younger folks using social media to show how much fun "us space techies" are having.

While some large grants helped do the engineering and build the payload, young, enthusiastic members of AmGEO conducted fundraising campaigns that targeted the largest organizations involved in space. It turns out that space organizations are willing to engage young folks after some young tech influencers pointed out that companies that were willing to donate to AmGEO were probably some of the best companies to work for. Even NASA and the US Space Force contributed "in kind" donations of publicity within their areas of influence. AmGEO learned from the mistakes of other organizations that membership needs to be free to all so that everyone can learn and experiment and have fun together, regardless of financial status or where you live. Most of the operating expenses of AmGEO are covered by older members who chose to financially support AmGEO-200. It doesn't hurt that AmGEO transmits the names and callsigns of sponsoring members during the monthly AmGEO meeting held on AmGEO-200.

In many ways AmGEO-200, and the formation of AmGEO, revitalized Amateur Radio. AmGEO-200 "evangelism" proved so successful that "next generation" Amateur Radio activities like AmGEO-200 became widely known in the public, especially among techies, makers, STEAM programs in schools, and college engineering programs. AmGEO developed a

number of outreach programs to engage young folks modeled on the successful programs of Amateur Radio on the International Space Station (ARISS) and Ham Radio Science Citizen Investigation (HamSCI). A lot of classrooms, makerspaces, and Amateur Radio clubs built receive-only AmGEO-200 ground stations with help from AmGEO grants.

Amateur Radio Networking

By the late 2020s, Amateur Radio networking re-emerged to become fun again and a large number of Amateur Radio Operators discovered that the technology of the 2020s had overcome a lot of issues with previous Amateur Radio networking of previous eras, especially given that wide area linking could be done via AmGEO-200 instead of via Internet. Texas and other western states were particularly glad to use AmGEO-200 for linking.

One of the biggest changes in Amateur Radio networking in the 2020s was that most Amateur Radio repeaters were upgraded from legacy modes by installing a repeater system from *Amateur Digital Repeater Systems (ARDS)* that used a pair of Software Defined Radios and a powerful computer. Repeaters using ARDS are "mode agnostic". When a user transmits to an ARDS repeater using M17, or DMR, or data, the repeater's output is M17, DMR, and data. ARDS implemented a "trunking" system so that users could access the repeater with best coverage in their area and communicate seamlessly with a buddy elsewhere in the region. This also made over-the-air wide-area nets / seminars / events much more feasible.

ARDS also popularized single frequency repeaters based on Time Division Multiplexing (TDM). TDM repeaters alternate between receive and transmit every 100 mS. Thus the ease of installation of a digipeater using a single frequency was combined with the throughput of a repeater and a lot of individual Amateur Radio Operators located at high points or with high towers set up TDM repeaters. What little coordination was necessary for TDM repeaters was easily done by listing one's TDM repeater on a web page.

Another big change in Amateur Radio networking was that most Amateur Radio Operators began installing a dedicated software defined receiver to monitor all Amateur Radio activity on all the Amateur Radio VHF / UHF bands - 50 MHz, 144 MHz, 222 MHz, 430 MHz, 440 MHz, and 1240 MHz. The first example of that idea was the KrakenSDR which combined five software defined receivers in a single unit with a common time base. Each of the KrakenSDR's receivers could receive from 24 MHz to 1766 MHz. The original use case for the KrakenSDR was to do transmitter triangulation, but a neat software package - *AllVU* enabled KrakenSDR to monitor *all* the Amateur Radio VHF / UHF bands simultaneously, all modes. AllVU was based on work by Phil Karn KA9Q in the early 2020s called KA9Q Radio. Installing an AllVU receiver was a great first step for prospective Amateur Radio Operators - they could at least receive repeaters, bulletins, etc. prior to getting their Amateur Radio license.

The combination of ARDS and AllVU made it feasible for repeaters to "transcode" - the repeater would receive all transmissions, and transcode them into a standard digital output which could be received by AllVU. Thus users could easily chat with another user that was using a different mode.

As compute power got cheaper and more powerful such as the *Raspberry Pi 5* with 16 GB of RAM 8 cores operating at 1.5 GHz for $75, mesh networking in Amateur Radio became

commonplace. With that much cheap compute power, and cheap software defined receivers such as AllVU, a mesh network technique first proposed in 1995 by Tim Shepard KD1KY could finally be implemented. KD1KY prosed a mesh network where each node broadcast a proposed time slot that it would transmit and eventually the mesh network would “settle into stability” with minimal collisions and hidden transmitters.

A background process of AllVU was "discovery” that monitored for transmissions from other Amateur Radio stations within range. When AllVU heard a transmission from another Amateur Radio station, AllVU would log that transmission and if the station was equipped with an AllVU transmitter, it would try to link up with the heard station with a handshake, exchanging station capabilities, routing tables, etc. Thus stations that were capable of transmitting to AmGEO-200 acted as gateways for other Amateur Radio stations that weren’t.

Amateur Radio VHF / UHF technology evolved rapidly once software defined radio technology became nearly universal and easy to use. It turned out that software defined radio technology didn’t need to evolve very much from the technology of the early 2020s. Mostly, SDR needed packaging / presentation layer work, and a reasonable transmit power. Few understood just how capable software defined radio was until *Amateur Networking Technologies (AmNET)* commercialized the work done by The Austrian Amateur Radio Society (ÖVSV) in developing the first practical software defined transceiver for VHF / UHF (RPX-100) into their *Universal Digital Amateur Radio (UDAR)*. One significant benefit of UDAR was that all of the VHF / UHF bands were usable - if the popular 440 MHz band was too busy, the UADR could “slide over” to the 222 MHz band to transmit. Between UDAR’s ability to transmit on any VHF / UHF band, and most Amateur Radio Operators installing an AllVU software defined receiver to receive on any VHF / UHF band, Amateur Radio networking really took off.

Once Amateur Radio transceivers were based on SDR that users could modify, technologies such as Orthogonal Frequency Division Multiplexing (OFDM), Time Division Multiplexing (TDM), Forward Error Correction (FEC), and entirely new modulations were easy and fun to implement. Even if you wanted to use some exotic technique like Coherent CW, you could still stay in touch with your friends because your AllVU receiver was listening for anyone that wanted to get in touch with you.

Another AmNet product, the *BB-100* (BB - Black Box) was a simple “black box” whose user interface was a smartphone / tablet app or a web app running within a computer’s web browser. BB-100 was popular with younger Amateur Radio Operators because apps on smartphones were a lot more familiar user interface than a dedicated control panel. Variants of the BB-100 quickly became preferred for vehicular use and even other usage scenarios - bicycling, hiking, etc. because smartphones have highly usable mounting systems - vehicles have reserved space for smartphones, bicycles have handlebar mounts, and you can strap your smartphone to your forearm while you’re hiking.

AmNET succeeded where other Amateur Radio vendors that offered units based on SDR failed because AmNET wholly embraced open source methodologies, with some practical business caveats. AmNET provided highly competent support only for units that it manufactured, and supported a small set of software loads, for one year from purchase. Beyond one year, AmNET offered extended support contracts at reasonable prices so that it could fund ongoing support. AmNET’s products were free and unrestricted to do whatever the customer wanted to do on their AmNET units (other than program them for use outside the Amateur Radio bands). Other

vendors were free to “clone” AmNET’s open source designs, but AmNET’s great support policies for its hardware and software made for a loyal customer base and a sustainable business model.

Amateur Radio Standards Organization (ARSO)

The *Amateur Radio Standards Organization (ARSO)* was formed for a pragmatic reason. Amateur Radio Operators, and Amateur Radio organizations were free to create entirely new modes as long as those modes were publicly documented. Before ARSO was formed, documentation for Amateur Radio technologies were (mostly) in public, but sometimes hard to find. This caused some consternation in the mid-2020s when the FCC and US Department of Defense (DOD) accused a small group of Amateur Radio Operators in New Mexico of using encryption in Amateur Radio spectrum. The accused Amateur Radio Operators responded that they were just using an obscure modulation technique, but none of them could find where that obscure modulation technique was publicly documented. ARDC provided a grant to establish ARSO with a website and some contracted labor from various universities with strong radio technology curriculums. ARSO quickly became a clearinghouse for documentation of almost all Amateur Radio technologies. ARSO developed a simple identifier that could be transmitted with most digital modes, allowing very easy lookup of the technology used for every transmission.

One minor illustration of the utility of ARSO was the consolidation of TCP/IP port numbers for various functions for better commonality between various units and software. Another was acting as an intermediary for obtaining unique Media Access Control (MAC) addresses for Ethernet and Wi-Fi devices used in Amateur Radio so that Amateur Radio interoperated smoothly with non Amateur Radio systems. Prior to ARSO assuming this role, obtaining MAC addresses, and identifiers for new devices with USB ports, was cumbersome and expensive for small vendors such as Amateur Radio manufacturers.

The formation of ARSO solved another growing problem in Amateur Radio - authentication. As Amateur Radio became more popular, a few bad actors occasionally tried to “horn in on the fun” without having an Amateur Radio license. ARSO developed a reasonable, universal authentication and registration system for Amateur Radio Operators worldwide, allowing Amateur Radio Operators to use their authentication signature for all major Amateur Radio systems such as accessing AmGEO-200.

Universal authentication also helped solve a nagging issue in Amateur Radio - the historical ban on using encryption in Amateur Radio. There had always been corner cases such as emergency communications involving sensitive information where encryption was considered necessary. The combination of qualification via the US government’s Federal Emergency Management Agency (FEMA) and authentication was a workable compromise. Amateur Radio Operators that wanted to qualify to use encryption for emergency communications had to be licensed for at least two years, and submit to a background check / qualification process that wasn’t any more onerous than participation in the various US military auxiliary communications programs. Amateur Radio Operators that (attempted to) use encryption but didn’t go through the background check / qualification process were quickly identified, found, and “given a stern talking to”.

ARSO Conferences

In the early 2020s, there were a number of Amateur Radio conferences such as Digital Communications Conference (DCC), AMSAT Annual Meeting, and the various large events such as HAM Radio Friedrichshafen, Ham Fair, Hamvention, and Hamcation. ARSO decided that conferences were part of its mission, and decided to have more frequent and more accessible conferences. ARSO holds one-day "companion" conferences adjacent to the major Amateur Radio events for discussion of new technologies. The subject matter of the annual GNU Radio Conference (GRCon) so closely overlapped with Amateur Radio that ARSO considered GRCon just another Amateur Radio conference.

ARSO conferences received funding to be inclusive and comprehensive. All presentations at ARSO conferences were streamed live, video recorded, and edited for clarity. Post conference, all presentation videos were publicly available, audio was transcribed into text, and the presenter's slide deck, or still photos of slides were excerpted from the video. This standardized approach to conferences began generating considerable "cross fertilization" especially between Amateur Radio Operators in different countries. The ARSO conference held in conjunction with Ham Fair was particularly popular as few US Amateur Radio Operators were conversive in Japanese to understand presentations made at Ham Fair.

ARSO conferences also revived the practice of putting out a Request for Student Papers (RFSP) for students to present their ideas at an ARSO conference. This was pioneered by Greg Jones WD5IVD at the 1996 DCC. Participation in the ARSO conferences generated even more interest in Amateur Radio among students.

Amateur Radio Internet

While AmGEO-200 and practical, fast, reliable networking on VHF / UHF reduced the need for using Internet for Amateur Radio activities, Internet still had its uses in Amateur Radio. After being an experiment-in-progress for more than four decades, 44Net (the legacy 44.x.x.x IPv4 address block), became highly useful to mainstream Amateur Radio when ARDC spun out 44Net into a separate entity - *Amateur Radio Internet Services (ARIS)*. The small staff of ARIS was quickly able to implement a practical and free-to-use Virtual Private Network (VPN) service exclusively for Amateur Radio Operators and Amateur Radio applications. This allowed a lot of creative Amateur Radio applications that weren't practical or affordable using commercial Internet. One example was high-bandwidth connectivity to use AllVU software defined receivers for experiments such as monitoring newly launched Amateur Radio (and other) small satellites pioneered by Satellite Networked Open Ground Station (SatNOGS) and radio spectrum experiments by Ham Radio Science Citizen Investigation (HamSCI). Sharing live video streams of their radio "shacks" and antenna system also became popular, especially during events like Earth Moon Earth (EME) events where cameras mounted on the antennas focused on the Moon.

The motto of ARIS became "Use Amateur Radio whenever possible to support Amateur Radio activities - doing so is useful and fun and educational. If using Amateur Radio isn't reasonable, we're here to help you use ARIS."

While 44Net and ARIS were created to operate 44Net and Internet connectivity for the benefit

of Amateur Radio, ARIS (in cooperation with ARSO) eventually added a new mission - promoting IPv6 in Amateur Radio - not only for interoperability with Internet, but using IPv6 *on* Amateur Radio spectrum. One of the biggest benefits of the IPv6, especially in VHF / UHF networking was there was no longer any need for using the Network Address Translation (NAT) "hack" for scarce IPv4 addresses.

ARIS and ARSO provided a lot of support for transitioning from NAT to IPv6, but in the end, that transitory pain was well worth it. One notable early conversion to IPv6 with ARIS help was Amateur Radio Emergency Data Network (AREDN) which had previously used the "private" 10.x.x.x address space. ARIS helped AREDN secure a block of IPv6 addresses that made AREDN networks much more robust and easier to administer. ARIS worked with AREDN to build an easy to use portal that assigned unique IPv6 addresses to every new AREDN node.

Amateur Radio Regulatory Updates

It took a concerted effort, but in the late 2020s, the FCC finally began to "care" about Amateur Radio again. Part of that change was driven by the impossible-to-ignore success of AmGEO-200 with the *Making Amateur Radio Cool Again* (that was the internal name) campaign by social media influencers. But another, more subtle effort was a low-key campaign to reach out to FCC personnel, including the five FCC commissioners. *Operation Reach Out* was mostly pragmatic efforts like offering monthly lunchtime seminars onsite at the FCC explaining about all the facets of Amateur Radio and how involvement with Amateur Radio helped motivate students to consider careers in radio technology. Another was offering personal invitations to FCC personnel such as the commissioners to visit events such as Field Day and *Moonbounce Night* held quarterly. Another was providing lists of qualified, patient, and available Amateur Radio Operators that FCC personnel could quickly consult to help understand Amateur Radio issues when they inevitably arose. When there were events on site at FCC headquarters that touched any aspect of Amateur Radio, Operation Reach Out volunteers could be counted on to attend and if necessary, represent Amateur Radio.

Although it's not as well-known in Amateur Radio as the FCC, the National Telecommunications and Information Administration (NTIA) is sometimes referred to as "The US Government's FCC". Operation Reach Out was duplicated for the NTIA, but given the NTIA's different focus from the FCC including spectrum assigned to the US government and DOD, a different group composed mostly of former military / government personnel did the outreach to NTIA.

As a result of those efforts and the impossible-not-to-notice surge in the popularity of Amateur Radio and increase in Amateur Radio licensees, the FCC eventually relaxed and in some case eliminated many of the onerous Amateur Radio regulations. The *New Millennium*2 *Amateur Radio Regulations Update* retained some basic regulations - the requirement to obtain an Amateur Radio license to use Amateur Radio spectrum, some segmentation of spectrum usage by license class, and reserving a few portions of spectrum for those who enjoy legacy modes such as CW. The legacy modes regulation was described as akin to allowing antique vehicles (that don't meet current requirements) limited use on public roads.

The New Millennium Update ended up remarkably similar to an imagined future in a speech by

Lyle Johnson [then] WA7GXD at the ARRL and TAPR 1996 Digital Communications Conference, which he pithily summarized as:

> My feeling of how Part 97 should read is easy — "Here's your band limits. Have a nice day." I think we could fit the whole of Part 97 on this side of this three by five card in large type. So that even a bifocal guy like me could read it without glasses.

As mentioned previously, some encryption was allowed in narrow circumstances, including recognition (but not encouragement) that accessing services on the Internet almost always force the use of encryption techniques. The new regulations essentially said "we hope limited use of encryption in Amateur Radio doesn't become a problem that we have to revisit". The prohibition against "professional Amateur Radio Operators" (no pecuniary interest) was retained. Another enhanced regulation was "experiment, but document" which the FCC was comfortable with given the success of ARSO at centralizing documentation of new modes and "encouraging" Amateur Radio Operators to use easy-to-reference identifiers.

Once the New Millennium Update took effect, Amateur Radio became even more active because companies involved in radio technology quickly recognized that making new technologies available for use in Amateur Radio allowed widespread testing that companies could quickly port to other portions of spectrum / other radio services, and other countries. While companies couldn't do such testing themselves (no pecuniary interest), the new regulations allowed (borderline encouraged) companies to loan equipment, etc. to Amateur Radio Operators to try out on Amateur Radio.

One example of the success of this approach was that various US government agencies implemented a long overdue program to update a "network" of various environmental monitors such as rivers, streams, sea levels, air quality, etc. modeled on technology pioneered in Amateur Radio. *USG Sensor Network 2027* used technology from ARDS repeaters, AllVU receivers, and mesh networking on US Government VHF frequencies instead of commercial satellites, license-exempt spectrum such as 902-928 MHz, and other expensive, proprietary technology and services. Very remote sensors that were outside of the range of VHF / UHF were converted to use HF radios and "thin telemetry" based on WSJT modes developed by Joe Taylor K1JT. These updates allowed much more detailed environmental monitoring at significantly lower cost than the older systems.

Amateur Radio Omnipedia

Most of Amateur Radio's history was in the 20th century - pre-Internet. By the early 2020s, it was recognized that a lot of Amateur Radio's history was literally getting thrown in the trash as the oldest segment of the Amateur Radio population began to die out and families had no good way to donate Amateur Radio media such as magazines, books, and manuals. An early ARDC grant to the Internet Archive created the Digital Library of Amateur Radio & Communications (DLARC), but that only solved the "archival" issue. Information in DLARC was barely categorized and discovery and browsing wasn't easy.

Various individual Amateur Radio Operators and groups had tried to place Amateur Radio information in Wikipedia, but the vast majority of Wikipedia volunteer editors knew nothing of Amateur Radio so a lot of Amateur Radio information on Wikipedia was removed or "dumbed

down" by (non-Amateur Radio) volunteer editors. A group of Amateur Radio Operators, mostly those that had some experience in writing, obtained an ARDC grant to create the Amateur Radio Omnipedia; essentially a clone of the Wikipedia infrastructure, with content specific to Amateur Radio. The first task of the Omnipedia editors was to create an easy to use index of all the material archived in DLARC. The second task that the Omnipedia editors decide to tackle was to index all known Amateur Radio media, including YouTube (and other) videos, podcasts, books, etc. After several years of work building the Omnipedia, if you wanted to find information on how (and why) to make a circularly polarized antenna for Amateur Radio satellites, the Omnipedia provided an explanatory overview article, and references to videos, how to articles, 3D printed parts, etc. The ease of use of the Omnipedia was yet another part of the virtuous cycle in the popularization of Amateur Radio in the 2020s.

Funding for Amateur Radio

By the end of the 2020s, ARDC had been making grants for most of a decade, pumping $5M or more per year into Amateur Radio, Research and Development, and Education (mostly for scholarships). This had enormous ripple effects throughout Amateur Radio. While ARDC grants were initially "micro to maxi", funding very modest projects under $10k to $millions, ARDC eventually decided to mostly fund long term activities and larger projects such as AmGEO-200, operational expenses at ARSO, ARIS, and the Amateur Radio Omnipedia and the ongoing work of DLARC. ARDC supported, in part, the highly successful Operation Reach Out at the FCC and NTIA.

ARDC also began funding an annual competition called *Amateur Radio Showcase* for media studies students to create documentary videos about Amateur Radio. As with all things ARDC provided funding for, these documentary videos were required to be publicly accessible. Being free to use, these high quality, informative videos not only showed up on YouTube and other video services, but began showing up on community access "cable" channels, being used in classrooms, and even used as part of Operation Reach Out. ARDC (and Amateur Radio) really knew it was onto something when one creative student documentarian created a humorous documentary celebrating the "slightly whacky" side of Amateur Radio such as museum-quality collections of (hundreds) of radios, exquisite craftsmanship involved in "homebrew" radios, spark gap transmissions from a restored radio from the 1920s, Earth Moon Earth communications (using impressively large antenna arrays), hidden transmitter ("bunny") hunts by elementary school kids, DXpeditions, mountaintop VHF / UHF / microwave contesting, creating commercial quality software "just for fun", maintaining a repeater on Oregon's Mount Hood (that is required to be completely hidden from view)… and many other interesting and fun aspects of Amateur Radio.

A notable ARDC grant was to "productize" the very powerful, but very geeky, GNU Radio software defined radio system. GNU Radio and its companion graphical user interface (GNU Radio Companion) was powerful and capable, but not easy to learn, or use, and its documentation wasn't maintained along with its rapid evolution. ARDC provided a multi-year grant to pay software developers to make GNU Radio as easy to use as commercial applications software, along with comprehensive, up-to-date documentation. ARDC also funded a video instruction series for GNU Radio. Once this foundational work was completed, another ARDC grant funded a fork of GNU Radio and GNU Radio Companion specifically for use with Amateur Radio with built-in interfaces for all popular Amateur Radio hardware and software.

For example, every new specification or device registered with ARSO automatically generated a "block" of GNU Radio code.

In the mid-2020s, ARDC began providing supporting grants to schools, makerspaces, and museums where the emphasis was on exposing youth to technology, especially those with high populations of disadvantaged students. The success of this new "learn something to *do* something" approach was hard to assess until a study commissioned by ARDC showed that these programs did encourage more students to consider technical careers.

By the end of the decade, ARDC wasn't alone in providing substantial grants for Amateur Radio projects and infrastructure. Companies began funding various projects in Amateur Radio, including funding individual contributors to develop or enhance new radio technologies, similar to the way companies had funded individuals and employees to work help develop Linux early in its history. One example was an Internet services company decided they wanted to make their name better known among the Amateur Radio Operators involved in ARIS. ARIS agreed to accept partial funding from them and from ARDC. (The company wanted to take over sponsorship of ARIS entirely, but no one wanted to trust a company for entirely funding such important Amateur Radio infrastructure.)

Emergency Communications

By the late 2020s, most emergency response organizations had migrated their "in-theater" emergency communications to a combination of satellite phones and satellite push-to-talk (PTT) radios from Iridium, FirstNET's hardened cellular services provided by AT&T, and broadband Internet via Starlink satellite. For example, by the mid 2020s, mobile command posts at every public safety agency was equipped with a nomadic Starlink terminal on its roof. Once the unit was stationary and had access to clear sky, in a few minutes the command post was online with low-latency broadband Internet service.

By the late 2020s there were fewer and fewer roles for Amateur Radio emergency communications except in rare circumstances. As demonstrated by the Information Technology Disaster Resource Center (ITDRC) organization, the primary need for volunteer communications expertise in emergencies became providing Internet and Wi-Fi to those affected by disasters. Amateur Radio Operators began migrating their skills to setting up extended microwave networks, setting up streaming cameras to monitor things like key traffic intersections and flooded areas, and configuring emergency VOIP telephone service.

Use of HF was one area where traditional Amateur Radio expertise remained valuable in emergencies. Even with Iridium, FirstNET, and Starlink, it was hard to beat the "bang per buck per pound" combination of a travel case with a wire HF antenna and some rope, a small HF radio, a modem and laptop, and a (lightweight) battery for being able to communicate from anywhere on the planet. Advanced data modes for HF based on OFDM provided reasonable data rates with reasonable reliability.

In Conclusion

There was no single factor that sparked the renewed popularity of Amateur Radio in the 2020s. The new technology available in the 2020s certainly helped, as did the regulatory updates and

the creation of the Omnipedia, but those were supporting factors. The renewal of Amateur Radio resulted from a confluence of involvement such as the social media marketing of AmGEO-200 that showcased modern Amateur Radio to the public, the availability of funding from ARDC for key infrastructure projects and organizations, and the willingness of capable Amateur Radio Operators to come together to populate those projects and organizations.

Looking back over the 2020s, the primary factor of the renewal of Amateur Radio was the only thing that ever really matters in whether something good happens, or not - the decision of enough people that care enough about something to get involved. With involvement, nothing is impossible.

I hope you enjoyed this optimistic tale of Amateur Radio in the 2020s.

de Steve Stroh N8GNJ

Feedback Loop

Zero Retries 0078 received the most comments of any issue of Zero Retries to date. My thanks to Jordan, Nate Bargmann, and ReadyKillowatt for some stimulating discussion.

Join the *Fun* on Amateur Radio

If you're not yet licensed as an Amateur Radio Operator, and would like to join the fun by *literally having a license to experiment with radio technology*, check out
Join the Fun on Amateur Radio for some pointers.

Closing the Channel

In its mission to highlight technological innovation in Amateur Radio, promote Amateur Radio to techies as a literal license to experiment with wireless technology, and make Amateur Radio more relevant to society in the 2020s and beyond, Zero Retries is published via email and web, and is available to anyone at no cost. Zero Retries is proud *not to participate* in the Amateur Radio Publishing Industrial Complex, which hides Amateur Radio content behind paywalls.

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- Amateur Radio Weekly consistently surfaces "Zero Retries Interesting" stories.
- Andreas Spiess HB9BLA's YouTube Channel - HB9BLA Wireless features Zero Retries Interesting content.

- The Substack email publishing platform makes Zero Retries possible. I recommend it for publishing newsletters.

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Zero Retries (N8GNJ) is on Mastodon - n8gnj@mastodon.radio - just click:

Zero Retries / N8GNJ on Mastodon

Email issues of Zero Retries are "instrumented" by Substack to gather basic statistics about opens, clicking links, etc. I don't use such information in any way other than seeing that most subscribers actually do read Zero Retries.

More bits from Steve Stroh N8GNJ:

- SuperPacket blog - *Discussing new generations of Amateur Radio Data Communications - beyond Packet Radio (a precursor to Zero Retries)*

- N8GNJ blog - *Amateur Radio Station N8GNJ and the mad science experiments at N8GNJ Labs - Bellingham, Washington, USA*

Thanks for reading!
Steve Stroh N8GNJ / WRPS598 (He / Him / His)
These bits were handcrafted in beautiful Bellingham (The City of Subdued Excitement), Washington, USA.

2022-12-30

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[1]

All “invented” organizations, products, etc. in this article are, to the best of my knowledge, entirely fictitious at the time of this article.

[2]

It was the first substantive update of Amateur Radio regulations in the 21st century.